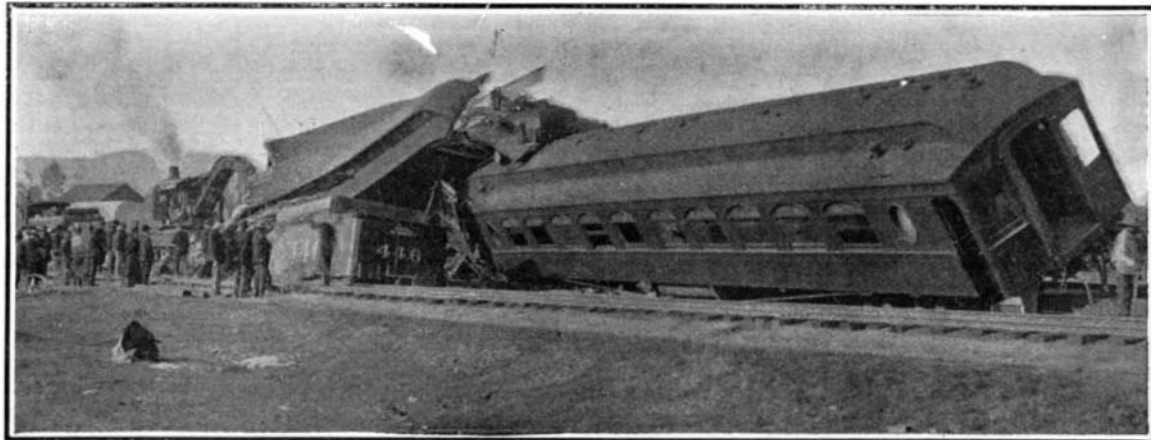


## WOODEN CARS IN A RAILROAD WRECK.

As a general rule, the SCIENTIFIC AMERICAN publishes photographs of railroad wrecks only when there is some definite lesson taught by the disaster. The accompanying photographs of a wreck which occurred on the first of March near Colton, Cal., on the Santa Fé Railroad, tragically illustrate both the ever-present

Not only should the switch signals be mounted on a lofty signal post, but a lofty, distant signal should be provided, and the two so connected that when the switch is open, both signals will show a red semaphore by day and a red light by night. If a clear distant signal were provided, as it unquestionably should be, we believe that accidents due to express trains, or

railroad companies. Ordinarily, the seats are merely screwed down to the flooring with wood screws, and undoubtedly the breaking away of the seats and the crowding of seats and passengers in a confused mass at the front end of the car is the cause of many severe fractures and contusions. Cast-iron legs and frames should be abolished, and replaced by light steel framing with the legs bolted, not screwed, to the floor.



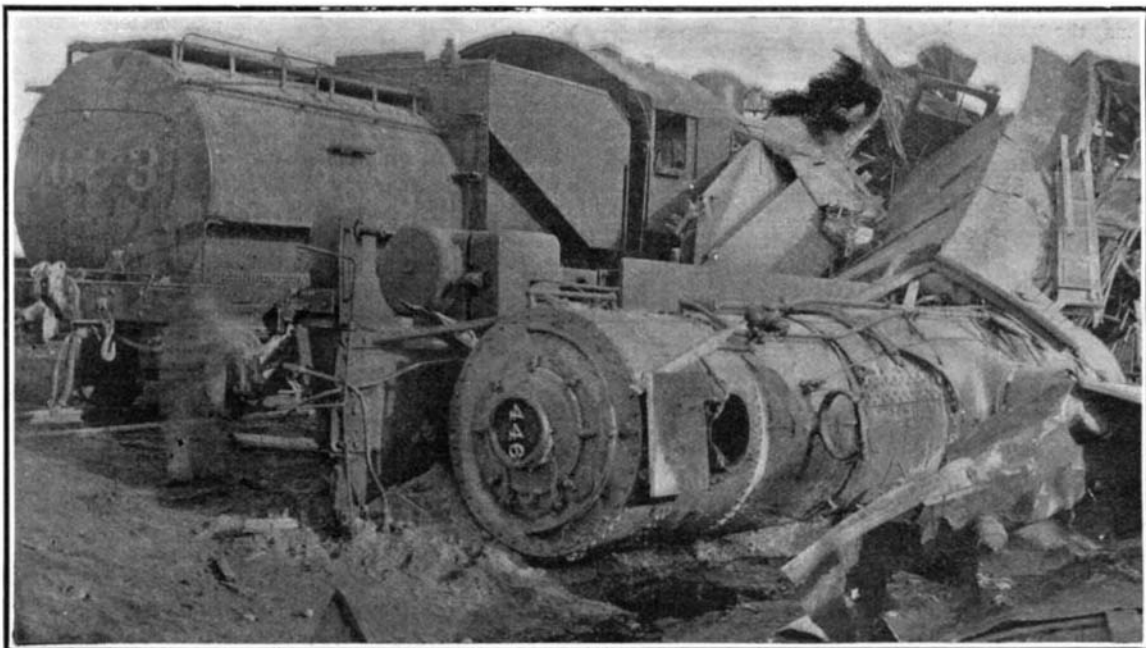
The Massive Vestibule Day Coach Crushed the Baggage and Smoking Cars into Fragments, but Itself Remained Practically Intact.

peril of the open switch and the frailty of the ordinary wooden passenger car, when it is placed between a heavy locomotive and a heavy Pullman car, and the train rushes at high speed into a head-on collision. In the present case, a passenger train, which was made up of a baggage car, a smoker, a vestibule day coach, and a Pullman observation car, was running at a speed of about fifty miles an hour as it approached a siding onto which a freight train had just backed, in order to give the passenger train a clear track. The train crew of the freight, by one of those fatal lapses of memory which are such a frequent cause of railroad disaster, omitted to close the switch, and the engineer of the passenger train failed to notice that it was open, until he was almost upon it. The centrifugal force as the engine attempted to swing around the sharp turnout was sufficient to overturn it bodily upon its side, and it ground its way over the roadbed for 150 feet before it came to rest, the tender breaking away at the point where it left the tracks. The train swept by the overturned locomotive and collided, practically at full speed, with the heavy engine of the freight train. The momentum of the vestibule day coach and the observation car drove the smoker into the baggage car and, as will be seen from our photographs, literally ground these two into fragments, the wreckage being more complete than anything we remember to have witnessed in a wreck of this character. Extraordinary to relate, only one person was killed outright, although two others were probably fatally injured, and a large number received minor injuries.

This wreck calls attention once more to the ever-present danger which exists in facing switches, which, while they may be eliminated on two-track roads, cannot be on single-track roads, on which the traffic runs in opposite directions on the same rails. Facing switches can be got rid of only by double-tracking, and the frequent occurrence of accidents of this kind proves that on the transcontinental roads, on which fast heavy expresses are run, double-tracking has become and, indeed, has long been, an urgent necessity. It is certain, however, that greater precautions could be taken to safeguard such switches. The provision of the present small dwarf signal, only a few feet high, at the switch points is a miserable and utterly inadequate safeguard.

indeed any kind of train, running into open sidings would become exceedingly rare.

The other lesson of the wreck is that the wooden day coach is literally a death trap in collisions, and cannot be too quickly superseded by the car of all-steel construction. To be convinced of this, it is only necessary to contrast the splintered wreckage of the frail smoker and baggage car with the practically intact under-frame and body of the vestibule day coach, whose



To the Right Is the Engine of Express; to the Left the Tender of the Freight.

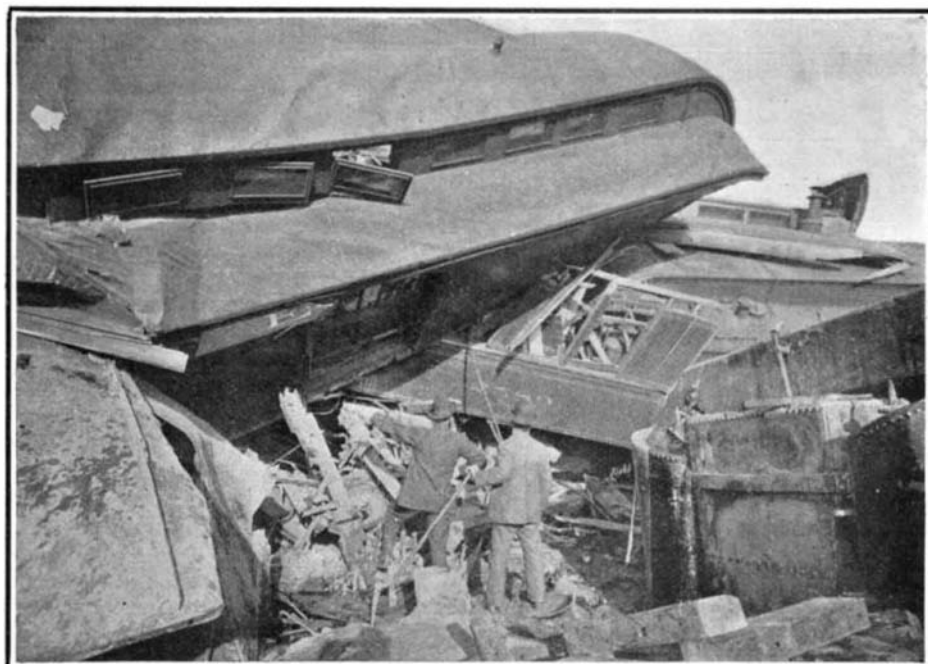
more massive construction seems to have suffered practically no injury, not even the glass of the windows being broken. That both the vestibule day coach and the observation car were subjected to terrific shock was shown by the fact that in both of them the momentum of the seats was sufficient to tear them from the floor and pile them in a heap at the front end of the car. Here, by the way, is a menace to passengers which could very easily be remedied, and at little cost to the

earthed by the workers, and were in perfect condition for the most part, because they had evidently been "fired away," if the expression can be applied to such ancient objects, the clay tablets being placed on edge, "reclining against each other like a shelf of leaning books in an ill-kept library of to-day."

Astute Arabs, rightly guessing that there were some monetary pickings in the relics that the members of the expedition sought in the ruins of Nippur, took a



Wreckage of Baggage and Smoker After They Were Crumpled into Fragments Between Vestibule Coach and Freight Engine.



Roof and One Side of Baggage, and Fragments of Smoker Immediately After Collision. These Adjoining Views Taken on Opposite Sides of Wreck.



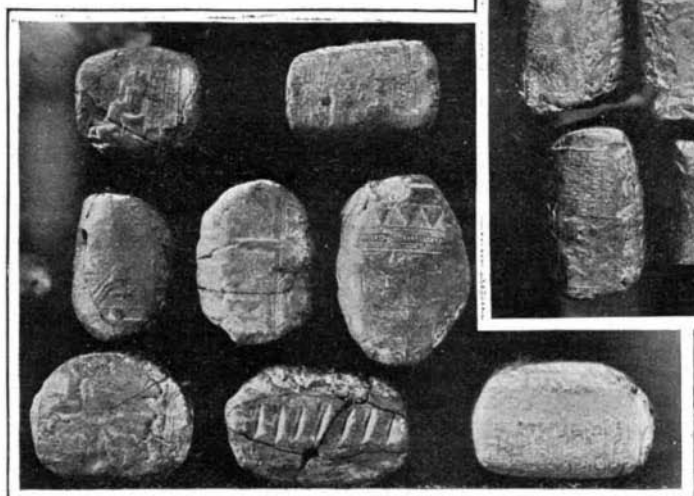
sly hand in the work, and through their reprehensible operations a number of tablets found their way to New York in the possession of private individuals. Some of these were deciphered with far too much airy freedom by the translator, but Dr. Clay has corrected errors in the interpretation of the signs on these tablets, so that the Babylonian data now in the possession of the University of Pennsylvania are as complete as care can make them. From the tablets translated by Dr. Clay it would seem that the saying regarding the futility of escape from death or the tax collector must first have been wailed forth from the overburdened soul of a resident of Nippur, 1400 B. C., for many of the documents found are records of receipts for rent or taxes from the outlying districts of the city. Others have reference to commercial transactions by those who had charge of the revenues. These reve-

plicated and unwieldy system of collecting and distributing revenues, when it is remembered that the taxes were paid in either grain or cattle.

Many of the tablets are records of business transacted between private individuals, and some of these are intensely interesting as throwing light on the life of the inhabitants of this ancient city. For instance, one self-sacrificing citizen, according to the chronicle of the tablets, took the place in a prison cell of an

good the crop that would have been raised by the owner of the ox, had he not been deprived of the use of his animal by the chapter of accidents related.

For a time it puzzled the translator of these tablets to know the meaning of little indentations, apparently made with a pointed instrument, by the side of the columns of record of disbursements made. It has been decided that these were the check marks of the person who made the payments. In modern parlance, as he



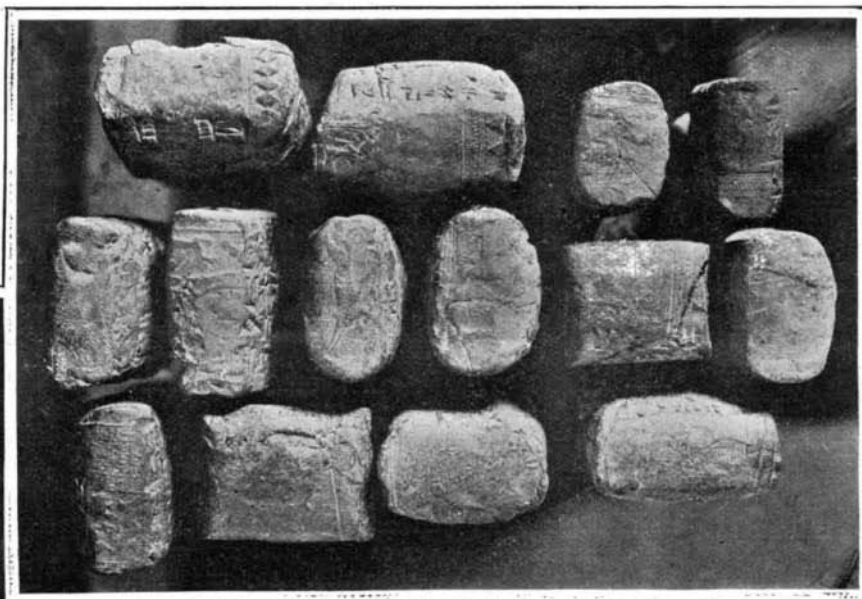
Tablets Showing Thumb Marks Instead of Seals.

nues were loaned out in the interest of the temple exchequer, the priests being very careful to charge interest on the money advanced. Still others record the payment of salaries to priests and to officials of the storehouse.

The taxes were paid, not in coin, but in natural products, such as corn, sesame, oil, dates, flour, and live stock. Although no record has been found to show the relative value of these articles, there was doubtless a regular rate of exchange in Nippur for the product of the farmer's toil. In most instances where the bookkeepers of Nippur recorded the payment of taxes, a note was made of the purpose for which it was paid. Thus one tablet states that grain was handed in for the maintenance of the priest, the temple servant, and the storehouse servant. Other payments are recorded as for the temple gateman, the singer, the temple shepherd, and for sacrificial purposes.

According to Dr. Clay, the records of the tablets show that in this ancient town, the temple of the god was not only the foremost institution of the city, but that it practically supported and controlled everything in the immediate vicinity.

They were careful bookkeepers in Nippur fourteen centuries before the birth of Christ, for these tablets also show plainly not only the nature of the tax collected, but the town from which it was received. In these outlying places the taxes were either transferred to Nippur or used in local civic disbursements—a com-



Tablet Envelopes, Showing Seal Impressions.

unfortunate priest who had got into the clutches of the law because of his failure to pay a debt.

A wise ruling revealed by the tablets is a case in which the concomitants are a farm crop, an ox with a broken leg, and a borrower who subsequently became a sorrower. The man who borrowed the ox obtained it from a farmer, who stipulated that the animal should be returned at a certain time, so that the work on his own farm should not suffer in consequence of his generosity. The borrower was unfortunate in that the ox broke a leg while working for the new driver, and in consequence the time for the return of the animal, which was the essence of the new arrangement, came and passed and the owner of the ox was unable to work his farm. The tablet shows that the borrower was compelled to make

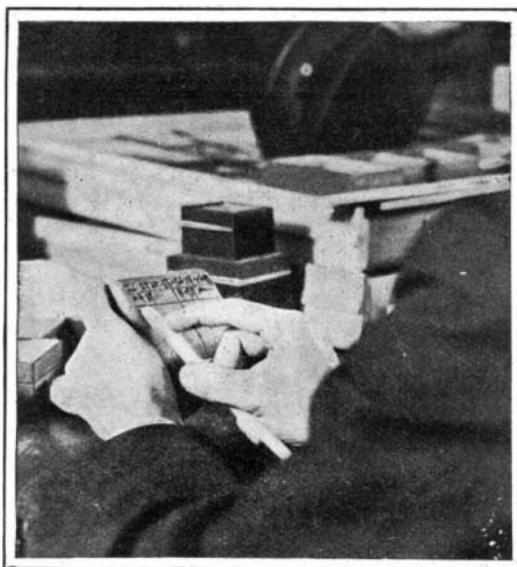
handed out the pay envelope the Babylonian bookkeeper checked off the amounts on the tablet in the way shown in one of the photographs, by making little impressions alongside the amount or name.

The use of the seal was all-important in the transactions of the business man of Nippur. It was an easy matter to forge a document drawn on one of the clay tablets, so the method employed to prevent this was to incase the tablet in a sealed envelope. Of these seals Dr. Clay says:

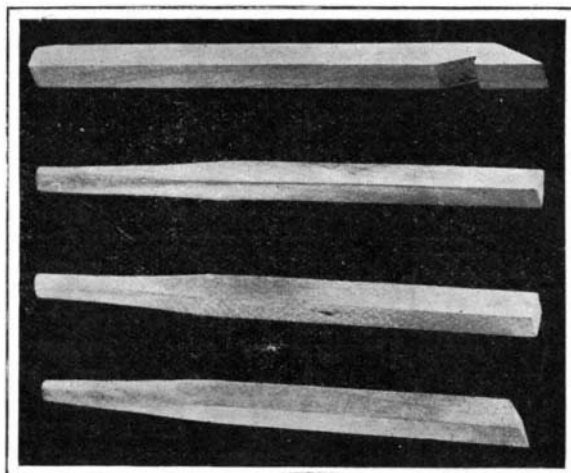
"The seal impression is equivalent to the signature of the modern document. It belongs to the man upon whom the obligation rests, or who is the recipient mentioned in the tablet, or to whom the goods are delivered. The only way that protection could be assured was to incase the tablet, and for the obligor to make impressions with his seal upon the envelope. The holder of the document might be able to make changes on the case, but he could not remove it to alter the tablet because he could not restore the envelope which bore the impress of the seal of the obligor."

Frequently instead of a seal there was a thumb mark, showing that the Babylonians were alive to the importance of the method of identification so widely exploited in the present day as an unerring means of connecting the mark with the originator.

Apart from the tablets themselves the most interesting thing about the ancient writing is the way in which it was done. There has been some controversy concerning the shape of the stylus used by the ancient scribe in forming the characters on these clay tablets. Dr. Clay has made several of these after the pattern



How the Stylus Was Used in Writing the Tablets.

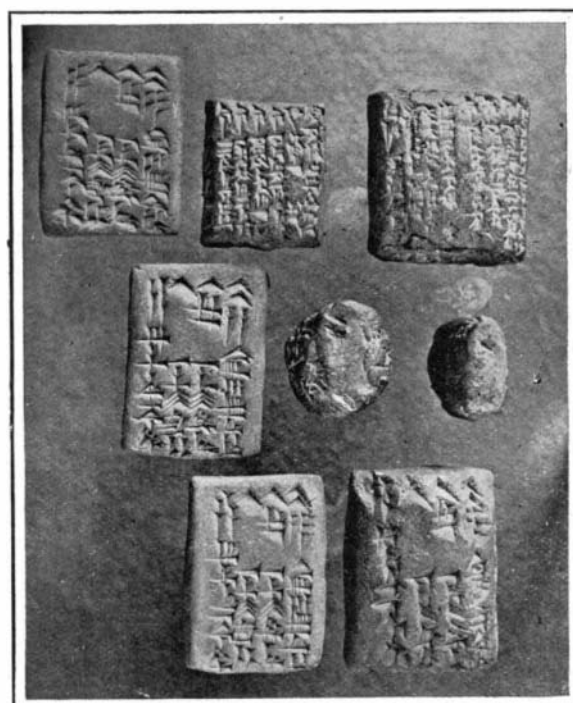


Supposed Forms of the Stylus as Reconstructed To-day.

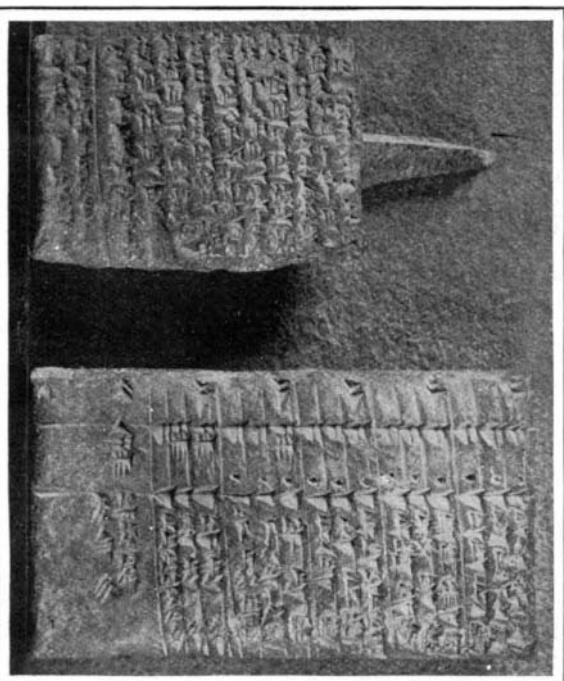
TABLET WRITING FROM THE RUINS OF NIPPUR.



The Payroll of the Officers and Servants of the Temple of Bel at Nippur.



Original Tablets, Tablet Envelopes, and Modern Replicas.



A Payroll Showing the Marks Where the Items Were Checked off by the Bookkeeper.



on which he believes the originals were constructed. Some of these are shown in the accompanying illustrations. None was found in the ruins. The manner in which these writing instruments were used is also shown in one of the engravings herewith.

#### CARBORUNDUM AND SILICON DETECTORS FOR WIRELESS TELEGRAPHY.

BY A. FREDERICK COLLINS.

A novel detector for determining the presence of electric waves, has just been brought out by General H. H. C. Dunwoody, and has been found sufficiently sensitive and trustworthy to be used for commercial wireless telegraphic work.

The device in question consists of a minute mass or fragment of carborundum—an artificial compound made of carbon and silicon in the electric furnace—held in place between two metallic terminals or conductor plugs, usually formed of copper or brass.

This detector has recently been made the subject of exhaustive tests by Mr. G. W. Pickard, who has found that it is somewhat less sensitive than the magnetic detector of Marconi, which in turn follows the electrolytic detector of Fessenden; that is to say, while it requires from 350 to 400 micro-ergs (1 micro-erg being 1/1000 of an erg\*) to operate the electrolytic detector, and from 400 to 500 micro-ergs to impress a magnetic detector, it requires between 9,000 and 14,000 micro-ergs to carry the conductivity of a carborundum detector so that it will produce an audible tone in a telephone receiver, with about the same amount of energy required by a microphone detector.

Notwithstanding this very considerable difference in the sensitiveness of the electrolytic and carborundum detectors when measured in the C. G. S. system of units, in the actual practice of wireless telegraphy the difference in receptiveness is barely perceptible over similar distances. In the first experiments with carborundum as an electric wave detector, it was found that its sensibility to the electric oscillations set up in the circuit of which it was a part, was a maximum when a certain critical potential prevailed in the local circuit of which it also formed a part.

In this respect it resembles the electrolytic detector when in action. For this reason a potentiometer or variable resistance is used in shunt with the detector. As carborundum is obtained in the form of crystalline masses, it has, in consequence, a very high resistance where the current flowing in the internal or dry cell circuit is small, but as the strength of the current is increased the resistance drops very rapidly.

Various curves have been plotted showing the resistance variation against the difference of potential across the conductor plugs of the detector, and in one of these it was demonstrated that the conductive charge occurred most rapidly between 1.0 and 1.1 volts. The conductance of the detector at this potential was about 250 microhms, or 0.4000 ohm, and a variation of 0.01 volt at the above potential value will produce a change in conductivity of about 10 microhms, or 4 per cent.

It is well known that the flat side of carborundum is a very poor conductor and in order to obtain good electrical contact, the sharp edges of the carborundum fragment must be clamped between the opposed surfaces of the plug ends of the detector, when the actual contact is limited to an exceedingly small area—not more than one millionth of an inch and probably less.

In common with the Fessenden hot-wire barretter and responders of the bolometric type, the action of the new Dunwoody detector is purely thermal. But instead of utilizing either an exceedingly fine metal wire of relatively low specific resistance and temperature coefficient, as does the barretter, or a large radiating or absorbing surface in proportion to its mass as does the bolometer, the carborundum detector employs a constricted current path lying along the edge of the crystal in contact with the oppositely-disposed surfaces of the conductor plugs.

The new carborundum detector is so designed that it can be inserted in circuit with a De Forest receptor instead of the detector formerly used; in other words, the carborundum detector is made interchangeable with the electrolytic detector, which it has superseded. When placed in such a receiving circuit, the manifestation is greatest when the potential impressed upon the detector is between 1.0 and 1.2 volts.

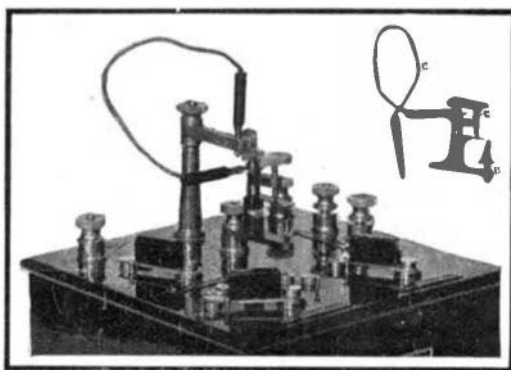
In other tests, the conductor plugs supporting the carborundum crystals were heated by a spirit lamp, when the resistance of the detector was observed to decrease greatly, but on cooling again it assumed its former resistivity, which is of the order of a megohm.

The crystals of carborundum employed in the Dunwoody detector are microscopically selected and only those having the sharpest edges are chosen, since these have been found to give the best result. The fragment of carborundum is placed between a spring and an adjustable screw plug, and by varying the

pressure of the spring by means of a screw the point of maximum sensitiveness can easily be obtained.

The exact proportions of the crystal are not essential and it may vary from one to three millimeters on the side. The crystal to be used should never be touched by the fingers, as this often reduces its sensitiveness to an appreciable extent; the proper way to handle the element is to use a pair of tweezers.

Since the advent of the Dunwoody carborundum de-



THE NEW DUNWOODY CARBORUNDUM DETECTOR INSERTED IN A RECEPTOR.

detector, Pickard has brought out one using silicon as the sensitive medium. Silicon is a non-metallic element, prepared as a dull-brown amorphous powder, as shining metallic scales or as dark steel-gray granules, sometimes showing crystallization. Any one of these may be used as a detector, and in any case it is pressed into good electrical contact between two conducting plugs as in the ordinary coherer.

Different from the coherer, this latest "thermo-electric regenerative detector" converts the energy of the oscillation set up in the receiving aerial, into heat at the junction of the silicon and the metal forming the conductor plugs by virtue of the high resistance of the former and the low resistance of the latter.

The amount of heat developed by the high thermo-electromotive force, and the consequent temperature rise, is proportional to the square of the resistance, according to the well-known law of Joule. The detector gets its name as indicated above from the fact that this thermal energy is converted or regenerated into a direct electric current, the detector performing the same function as all others that have been devised, namely, that of a very delicate relay.

A machine for applying screws at the rate of fifty a minute, if necessary, has recently been placed on the market and consists of a hopper connected by a vertical flexible shaft and tube to the driving mechanism below. The withdrawal of the bit from each screw as it is



THE DETECTOR APPLIED TO A DE FOREST RECEPTOR.

driven causes a new screw to drop out of a magazine and fall in line with the bit and also allows a screw to fall from the hopper into the magazine. The use of the intermediate magazine was found necessary, as the operation of the machine is so rapid that too much time would be wasted in waiting for it to drop from the hopper. The screws are caused to revolve at the rate of 1,200 revolutions a minute by means of a friction drive so adjusted that the screw stops after it has been driven the required distance.

#### LEDUC'S ARTIFICIAL PLANTS AND CELLS.

BY DR. ALFRED GRADENWITZ.

A strong reaction against the somewhat childish endeavors of the alchemists to convert one element into another and to generate living beings from inert matter, pervades the history of nineteenth century science. Perhaps we have been prone rather too eagerly to discard the doctrines of former times, banishing many theories which in the course of the last few years have again been found worthy of serious discussion.

We are no doubt at present on the eve of great revolutions in our scientific views; the phenomena of radioactivity have shaken the belief in the immutability of the atom and even the principle of the preservation of matter, at least in its familiar form. Nor does the distinction of three strictly separated states of aggregation stand the test of recent investigation; transitions are found to exist between the different states, and we are warranted in presuming that between the material and the immaterial (the luminous ether) there are likewise numberless intermediary states. Finally there have been discovered transitional stages between inert matter and living beings, from which many interesting conclusions in regard to the nature of life can be drawn.

While Prof. Lehmann's recent researches on apparently living crystals have shown that certain bodies, mineral in outward appearance, behave like living organisms of the lowest type (bacteria), Prof. Leduc, of Nantes, has found the vital functions in animal and vegetable cells to be controlled exclusively by the physical laws of diffusion (osmosis) and cohesion (molecular attraction). On the basis of these phenomena he has even succeeded in artificially producing objects which, not only in appearance but in behavior, closely resemble natural cells, growing, absorbing food, and propagating themselves in exactly the same way.

The botanist might be somewhat embarrassed when asked to incorporate in his familiar system of classes, orders, and families the forms illustrated in Figs. 1 to 4. Still he would hardly have any doubt of their genuineness, their whole aspect being typical of representatives of the vegetable kingdom, especially of certain water plants.

Nevertheless, they are not living beings of any sort, but artificial bodies formed in the laboratory of the chemist. While their very aspect is certain to inspire interest, it is obviously far more interesting to observe them in the making, to watch how from an artificial seed a shoot springs and develops (at a rate readily controlled by the experimenter) into stems, leaves, buds, twigs, ears, and blossoms, and after some time dies like a real plant. The birth and death of a plant can thus be artificially reproduced within the space of a few hours.

Below are given some details concerning the artificial seed and the medium in which it is immersed for germination. A seed one to two millimeters in diameter, consisting of two parts of saccharose (cane sugar) and one part of copper sulphate, is immersed in an aqueous solution containing two to four per cent of potassium ferrocyanide, one to ten per cent of sodium chloride or some other salt, and one to four per cent of gelatine. In this solution, the seed germinates in a few days or a few hours according to temperature; under favorable conditions the germinating process can even be shown as a lecture experiment in a few minutes.

The seed surrounds itself with a membrane of copper ferrocyanide which is permeable to water and to certain ions, but is impermeable to sugar. This semi-permeability produces a high osmotic pressure in the interior of the artificial seed, resulting in the absorption of matter from the surrounding medium and thus in the growth of the whole structure. If the liquid be spread on a glass plate, the growth takes place in a horizontal plane. In a deep vessel, on the other hand, the plant form grows simultaneously in a horizontal and a vertical direction, forming stems which on arriving on the upper surface of the liquid, spread out in flat leaves resembling those of a water plant.

A single artificial seed one millimeter in diameter can thus produce 15 to 20 vertical stems which sometimes reach a height of 25 to 30 centimeters, being either simple or branched, frequently carrying lateral leaves or twigs and terminals shaped like spheres, mushrooms, ears, spires, etc., according to the composition of the culture liquid.

These experiments thus prove that the functions formerly considered as being characteristic of the process of life are due to and controlled by purely physical forces. In fact, the forms in question obviously receive their food by intussusception or internal absorption like living beings, whereas crystals, as is well known, increase by external accretion. Furthermore, the plant forms are really organized, possessing all those organs (stems, leaves, and terminal parts) which are characteristic of plants. As finally the substance used in building up these artificial plants, viz., copper sulphate, rises in stems up to 30 centimeters in height (with a diameter of one millimeter) they are necessarily provided with an apparatus of circula-

\*In the C. G. S. system the erg is the unit of work and of energy, being the work done in moving a body through a distance of one centimeter against the force of one dyne, or the kinetic force of two grammes moving at the rate of one centimeter per second.